ORIGINAL RESEARCH

Efficacy of GreenLight laser prostatectomy in urinary retention

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Cite as: MacDonald A, Fathy M, Nikoufar P, et al. Efficacy of GreenLight laser prostatectomy in urinary retention. *Can Urol Assoc J* 2024;18(4):E120-6. http://dx.doi.org/10.5489/cuaj.8556

Published online December 21, 2023

ABSTRACT

INTRODUCTION: The objective of our study was to evaluate the efficacy and durability of GreenLight laser prostatectomy for the management of acute urinary retention (AUR) and chronic urinary retention (CUR) and to determine outcomes compared to patients without preoperative urinary retention (UR).

METHODS: We conducted a retrospective study of prospectively collected data from individuals who underwent GreenLight laser prostatectomy at our institution from May 2018 to July 2022. Patient demographics and outcome measures were recorded, including indications for the procedure, median urinary volume drained, or median postvoid residual urine volume (PVR) before catheterization or GreenLight laser prostatectomy. CUR was defined as PVR >300 mL in males able to void and initial catheter drainage >1000 mL in males unable to void in the absence of pain. All patients had postoperative followup visits at one, three, six, and 12 months. Our evaluation included the International Prostate Symptom Score (IPSS), quality-of-life (QoL) assessment, maximum urinary flow rate (Qmax), PVR, and catheter-free status.

RESULTS: One hundred sixty-eight males who underwent GreenLight laser prostatectomy were included in our study. The UR group consisted of 88 patients (50 AUR and 38 CUR), and the lower urinary tract symptoms (LUTS) group was comprised of 80 individuals. There were no statistically significant differences between the AUR and CUR subgroups regarding demographics. The UR group had a significantly higher age and a significantly higher postoperative catheterization time compared to the LUTS cohort. The CUR subgroup had a significantly higher PVR at one, three, and six months compared to the AUR subgroup, although other outcome measures were similar between the two cohorts. During three- and six-month followup visits, the UR group had a significantly higher PVR than the LUTS cohort. At 12 months postoperative, the LUTS group had a higher catheter-free rate than the UR group (p=0.001). The successful first trial of void (TOV) rate for the UR and LUTS groups were 83% and 80%, respectively. At 12-month followup, the catheter-free rate for the UR and LUTS cohorts was 87.5% and 100%, respectively.

CONCLUSIONS: GreenLight laser prostatectomy is an effective and durable treatment for UR, with a high catheter-free rate and comparable outcomes when performed to manage LUTS.

INTRODUCTION

Benign prostatic hyperplasia (BPH) is a common condition affecting many men, with increasing incidence as they age.[1] The consequences of BPH, lower urinary tract symptoms (LUTS), are progressive in nature and significantly impact daily activities and quality of life (QoL).[2] A serious complication of unmanaged BPH is urinary retention (UR), which if left untreated, can result in bladder dysfunction, poorer flow rates, renal insufficiency, and urinary tract infections (UTIs).[3,4] One randomized trial found that 2.9% of men with moderate symptoms of BPH who opted for watchful waiting went on to develop UR.[5]

UR can be classified in various ways, including chronicity. Defining acute (A) UR[6] and chronic (C) UR can be challenging, as they have been described quite variably in the literature.[6,7] A recent study looking at holmium laser enucleation of the prostate (HoLEP) for UR by Aho et al defined AUR as a painful form of UR, at any volume, with pain relief after catheterization. They labelled CUR as painless UR with a postvoid residual volume (PVR) >300 mL in men able to void and urine volume on initial catheterization >1000 mL in men unable to void.[8] In contrast, the American Urological Association defined non-neurogenic CUR as an elevated PVR >300 mL that persisted for at least six months and was documented on two or more separate occasions.[4] Undoubtedly, the varying definitions have provided challenges to managing and understanding these conditions.

While medical or surgical management are both recognized treatment options for men presenting with UR,

surgery may be preferred due to the high failure rates associated with medical management.[3] Moreover, UR is cited as the primary indication for surgery in 24–42% of men with BPH.[9] Historically, transurethral resection of prostate (TURP) has been the gold standard for BPH surgery; however, minimally invasive, laser-based procedures, such as HoLEP and GreenLight photoselective vaporization of the prostate (PVP), have become favorable alternatives to TURP due to their improved safety profiles and similar functional outcomes.[10]

While existing research suggests that these procedures are safe and effective in AUR and CUR populations,[3,8,11-13] no study has specifically compared the utility of GreenLight PVP in patients with BPH experiencing AUR, CUR, and no UR. Our primary objective was to evaluate the one-year outcomes of GreenLight laser prostatectomy in patients who presented with UR vs. those with LUTS. The secondary objective was to assess the effect of CUR and AUR on the early outcomes of GreenLight PVP.

METHODS

Following research ethics board approval, we performed a retrospective review of a prospectively collected database of patients who underwent laser vaporization of the prostate using GreenLight PVP at our institution from May 2018 to July 2022.

Study population

One hundred sixty-eight males who underwent GreenLight laser prostatectomy were included in our study. Patients that met the following conditions were excluded: previous surgery for bladder outlet obstruction, previous history of prostate cancer, presence of a urethral stricture or an active UTI. Additionally, individuals with a history of neurogenic bladder or any neurologic disease, such as uncontrolled diabetes, as well as those who had undergone previous spine or pelvic surgery, were also excluded from the study.

Patient demographics and outcome measures were documented, such as indications for the procedure, median urinary volume drained, or median PVR before catheterization or GreenLight laser prostatectomy. CUR was defined as PVR >300 mL in males able to void and initial catheter drainage >1000 mL in males unable to void, in the absence of pain.[8] Urodynamics (UDS) did not factor into the process of patient selection before performing laser prostatectomy on men with non-neurogenic CUR.

Various questionnaires were given to the participants to assess their International Prostate Symptom Score (IPSS) and QoL. A comprehensive physical exam that included a digital rectal exam (DRE) and a focused neurologic assessment was performed. All patients underwent basic laboratory testing, including prostate-specific antigen (PSA), uroflowmetry, PVR, and transrectal ultrasound (TRUS), to estimate prostate volume. If medically feasible, patients were instructed to temporarily hold their anticoagulant and antiplatelet medications prior to surgery for three and seven days, respectively. Intraoperative parameters, postoperative outcomes, disposition, and readmission data were collected and analyzed.

Surgical technique

All procedures were exclusively performed by one of two experienced urologists using the GreenLight XPS™ Laser System (Boston Scientific, Marlborough, MA, U.S.) with the MoXy™ 532 nm fiber and settings of 80–180 Watt output for GreenLight laser PVP. All surgeries were performed identically, including ablation down to the capsule. The laser vaporization time was determined as the duration required to carry out the laser portion of the procedure.

Routine postoperative

All patients had a three-way Foley catheter (22 F) with 30 mL of sterile water in the balloon placed in the operating room. They were kept on mild traction with continuous bladder irrigation (CBI) for two hours, which was then stopped for an additional hour. Predetermined discharge criteria included if the patient was medically fit, had a caregiver, was not on anticoagulant or antiplatelet medications at the time of surgery, and met post-anesthesia care unit (PACU) discharge criteria.[14]

After undergoing an assessment by the operating surgeon for discharge, all patients were offered a same-day trial of void (TOV) three hours postoperatively using the same protocol as our previous publication.[15] Participants with preoperative factors such as an unfit medical condition, including a cognitive disorder, anticoagulant therapy, and uncontrolled cardiovascular disease, were ineligible for early discharge. Patients who declined a same-day TOV were sent home with a Foley catheter, and a TOV was arranged the following day.

Participants were deemed eligible for discharge if they fulfilled the PACU discharge criteria based on the post-anesthesia recovery discharge score.[14] Patients were required to have an acceptable urine color without CBI, absence of clots, PVR <300 mL, and a residual volume of less than half the voided volume. Other discharge criteria included acceptable postoperative

laboratory values, independent ambulation, and the ability to tolerate a diet.

In cases where the patient was unsuccessful in passing their TOV, the catheter was replaced, and a subsequent attempt at a voiding trial was conducted within a week.

Followup

Participants were followed up at one, three, six, and 12 months. Postoperative followup visits involved clinical examination, assessment of IPSS, QoL, PSA, flowmetry, a bladder scan for PVR, catheter-free status, and cystoscopy if medically indicated.

Statistical analysis

Data acquisition and subsequent analysis were conducted using the Statistical Package for the Social Sciences (SPSS®) version 26.0 (Chicago, IL, U.S.). The data underwent rigorous evaluation through a univariate analysis. Continuous data were characterized by medians and their respective ranges, and their comparative assessment was carried out employing a non-parametric statistical test, specifically the Mann-Whitney U test. On the other hand, categorical data were represented using numerical counts and corresponding percentages, with their statistical comparisons being executed via the Chi-square test. A p-value <0.05 was deemed statistically significant.

RESULTS

The charts of 195 patients were reviewed. We excluded 27 patients: previous surgery for bladder outlet obstruction (12), previous history of prostate cancer (4), presence of a urethral stricture (2) or an active UTI, and individuals with a history of neurogenic bladder or previous spine surgery (8). Our study included 168 males who underwent GreenLight laser prostatectomy. The UR group consisted of 88 patients (50 AUR and 38 CUR), and the LUTS group was comprised of 80 individuals.

Patient characteristics are presented in Table 1. There were no statistically significant differences observed between the AUR and CUR cohorts. Among the CUR subgroup, three patients (7.9%) had suprapubic catheters, while the remaining patients (92.1%) had chronic indwelling urethral catheters. None of our cohort accepted clean intermittent cathterization as an alternative to indwelling catheters.

Table 1. Baseline clinical characteristics

Parameters	AUR (50)	CUR (38)	p	UR (88)	LUTS (80)	p
Age, years (median)	78 (59–100)	77 (64–87)	0.163	78 (59–100)	68.5 (43–91)	<0.001
ASA function class, n (%)						
I	6 (12)	3 (7.8)	0.762	9 (10.3)	1 (1.2)	0.100
II	12 (24)	12 (31.6)		24 (27.3)	16 (20)	
II	24 (48)	19 (50)		43 (48.8)	50 (62.5)	
IV	8 (16)	4 (10.6)		12 (13.6)	13 (16.3)	
Anticoagulants, n (%)	25 (50)	17 (44.7)	0.670	42 (47.7)	27 (33.8)	0.084
Initial PVR, mL (median)	915 (400–1000)	1000 (500–1250)	0.663	964 (400–1250)	–	–
Preoperative IPSS (median)	–	–	–	–	24 (8–35)	–
Preoperative QoL (median)	–	–		–	4 (2–6)	
Preoperative Qmax, mL/s (median)	–	–		–	8.5 (3–17)	
Preoperative prostate size by TRUS, g (median)	49.5 (22–68)	44 (19–80)	0.480	49 (21–80)	50 (20–113)	0.069
Preoperative catheterization time, months (median)	7.5 (1–84)	4.5 (1–48)	0.248	6.5 (1–84)	–	–

ASA: American Society of Anesthesiologists; AUR: acute urinary retention; CUR: chronic urinary retention; IPSS: International Prostate Symptom Score; LUTS: lower urinary tract symptoms; PVR: postvoid residual; Qmax: peak flow rate; QoL: quality of life; TRUS: transrectal ultrasound; UR: urinary retention.

The AUR and CUR cohorts exhibited comparable intraoperative and early postoperative findings (Table 2). The median duration of catheterization was longer in the UR group compared to the LUTS group (p<0.001). Patients with AUR and CUR had a similar rate of recurrent retention (p=0.87); however, the incidence of recurrent retention in the UR group was significantly higher compared to the LUTS cohort (p=0.008).

A successful TOV was observed in 83% of patients in the UR group and 80% in the LUTS group. While the CUR subgroup exhibited a higher occurrence of failed TOV at 23.7% (compared to the AUR subgroup at 12%), the difference observed was not statistically significant (p=0.148).

None of the patients in the UR group experienced intraoperative complications, while three individuals in the LUTS group had intraoperative bleeding that necessitated coagulation with TURP (p=0.07).

Nine participants (10.2%) in the UR group (six with AUR and three with CUR) had postoperative complications compared to 10 patients (12.5 %) in the LUTS group (p=0.667). Gross hematuria was observed in five individuals with AUR (10%) and two with CUR (5.3%). CBI was initiated for all hematuria cases.

One patient from each UR group had a febrile UTI (Clavien II), leading to hospital admission and management with intravenous antibiotics. Eight individuals from the LUTS group experienced gross hematuria and were managed with CBI (Clavien I), in addition to a single case of deep vein thrombosis (Clavien II) and an acute myocardial infarction (Clavien IV).

Postoperative followup (Table 3)

The AUR group had a significantly lower PVR than the CUR group at one, three, and six months (p=0.049, 0.001, and 0.001, respectively); however, at 12 months, both cohorts exhibited comparable PVR measurements (p=0.19). Additionally, other followup parameters were found to be similar among the groups.

At one-month followup, one patient (1.1%) from the UR group presented with stress urinary incontinence (SUI), which resolved at three months. In contrast, five patients (6.3%) from the LUTS group had SUI at

Table 2. Intraoperative parameters and perioperative outcomes

Parameters	AUR (50)	CUR (38)	p	UR (88)	LUTS (80)	p
Operative time, min (median)	56 (18–127)	52.5 (18–103)	0.486	54 (18–127)	54 (21–240)	0.535
Vaporization time, min (median)	44.5 (12–106)	37 (12–74)	0.292	42 (12–106)	40 (13–210)	0.504
Lasing time, min (median)	25 (8–59)	22.5 (8–49)	0.663	25 (8–59)	28 (8–183)	0.415
Energy, kJ (median)	169 (39–374)	188 (38–337)	0.258	173 (38–374)	181 (40–539)	0.306
Change in Hb, g/L (median)	8 (0–42)	11 (3–14)	0.398	8 (0–42)	10 (0–47)	0.444
Blood transfusion, n (%)	0	0	–	0	2 (2.5)	0.497
Intraoperative complications, n (%)	0	0	–	0	3 (3.8)	0.07
Length of hospital stay, days (median)	1 (0.25–1)	1 (0.25–1)	0.622	1 (0.25–1)	1 (0.25–14)	0.109
Postoperative catheterization time, days (median)	2.5 (0.125–7)	1 (0.125–7)	0.741	1.5 (0.125–7)	1 (0.125–30)	<0.001
Successful first TOV, n (%)	44 (88)	29 (76.3)	0.148	73 (83)	64 (80)	0.764
Recurrent retention after TOV, n (%)	6 (12)	5 (13.2)	0.87	11 (12.5)	0	0.008
Postoperative complications, n (%)						
Clavien I	5 (10)	2 (5.3)	0.655	7 (8)	8 (10)	0.667
Clavien II	1 (2)	1 (2.6)		2 (2.3)	1 (1.3)	
Clavien III	0 (0)	0 (0)		0 (0)	0 (0)	
Clavien IV	0 (0)	0 (0)		0 (0)	1 (1.3)	

AUR: acute urinary retention; CUR: chronic urinary retention; Hb: hemoglobin; TOV: trial of void; LUTS: lower urinary tract symptoms; UR: urinary retention.

Table 3. Postoperative functional outcomes

Parameters	AUR (50)	CUR (38)	p	UR (88)	LUTS (80)	p
1 month postoperative						
IPSS (median)	7 (2–19)	7.5 (3–11)	0.119	7 (2–19)	10.5 (1–24)	0.101
QoL (median)	2 (0–5)	1 (0–3)	0.103	2 (0–5)	2 (0–6)	0.208
Qmax, mL/s (median)	9 (8–34)	17 (10–29)	0.112	18 (8–35)	16 (5–48)	0.777
PVR, mL (median)	45 (0–700)	200 (0–400)	0.049	49 (0–700)	63 (0–500)	0.777
Stress urinary incontinence, n (%)	1 (2)	0 (0)	0.38	1 (1.1)	5 (6.3)	0.07
3 months postoperative						
IPSS (median)	8 (1–25)	4.5 (2–7)	0.06	7 (1–25)	7 (1–29)	0.428
QoL (median)	1 (0–6)	1.5 (0–3)	0.35	1 (0–6)	1 (0–6)	0.246
Qmax, mL/s (median)	15 (7–54)	9 (7–11)	0.878	14 (7–54)	20.5 (4–57)	0.084
PVR, mL (median)	100 (0–700)	158 (0–300)	0.001	100 (0–700)	40 (0–360)	0.005
Stress urinary incontinence, n (%)	0	0	–	0	1 (1.3)	0.476
% PSA reduction (median)	52 (43–88)	56 (16–70)	0.377	55 (16–88)	62 (5–100)	0.818
6 months postoperative						
IPSS (median)	7 (1–16)	3 (0–11)	0.156	7 (0–16)	6 (0–26)	0.592
QoL (median)	1 (0–3)	1 (0–1)	0.561	1 (0–3)	2 (0–6)	0.104
Qmax, mL/s (median)	21 (6–52)	16 (8–20)	0.425	20 (6–52)	20 (6–67)	0.11
PVR, mL (median)	72 (0–390)	290 (180–500)	0.001	98 (0–500)	32 (0–250)	<0.001
Stress urinary incontinence, n (%)	0	0	–	0	1 (1.2)	0.476
12 months postoperative						
IPSS (median)	5 (1–10)	2 (1–14)	0.797	4.5 (1–14)	5 (0–25)	0.506
QoL (median)	1 (0–3)	1 (0–2)	0.921	1 (0–3)	1 (0–4)	0.47
Qmax, mL/s (median)	17 (3–41)	18 (8–29)	0.717	17 (3–41)	21 (7–61)	0.303
PVR, mL (median)	60 (0–370)	341 (0–770)	0.193	107 (0–770)	57 (0–260)	0.106
Ongoing stress urinary incontinence, n (%)	0	0	–	0	1 (1.3)	0.476
Catheter-free, n (%)	44 (88)	33 (86.8)	0.87	77 (87.5)	80 (100)	0.001

ASA: American Society of Anesthesiologists; AUR: acute urinary retention; CUR: chronic urinary retention; IPSS: International Prostate Symptom Score; LUTS: lower urinary tract symptoms; PVR: postvoid residual; Qmax: peak flow rate; QoL: quality of life; TRUS: transrectal ultrasound; UR: urinary retention.

one month postoperative, and only one had persistent SUI at 12 months postoperative.

At the end of the followup period, all patients in the LUTS group were catheter-free, whereas 11 (87.5%) from the UR group still required indwelling catheters. These patients underwent flexible cystoscopy, which revealed no signs of obstruction.

One patient in the AUR group underwent urethroplasty for urethral stricture, while another patient in the CUR group had a bladder neck incision due to bladder neck contracture. Moreover, a patient in the LUTS group had a residual adenoma, necessitating reoperation with GreenLight laser prostatectomy.

DISCUSSION

Urinary retention requiring catheterization represents the culmination of BPH-related obstruction. It is felt, in part, to have a component of detrusor underactivity (DUA).[16] The safety and efficacy of surgical interventions for BPH have been a point of debate, with concerns mainly directed toward outcomes in males with DUA;[3,16] however, with the rising prevalence of laser-based options and a growing body of evidence to suggest their favorable safety profiles, there is renewed interest in the surgical management of this population. Consequently, we assessed the efficacy and safety of GreenLight PVP in patients with UR vs. LUTS, as well as between AUR and CUR.

Preoperative and intraoperative characteristics did not differ significantly between the AUR and CUR groups. Comparison between UR and LUTS cohorts revealed that the UR group was significantly older than the LUTS group (median age 78 vs. 68.5 years, p<0.001). This finding is perhaps unsurprising, given the progressive nature of BPH with increasing severity of obstruction and associated symptomatology as patients age.[1] Similar results have been observed in other studies assessing GreenLight or HoLEP in UR vs. LUTS patients.[8,12,17] A potential explanation comes from recent trends observed in BPH management. A shift favoring medical rather than surgical management may contribute to patients presenting for surgical intervention at older ages and with advanced disease, including larger prostates and UR.[3] While there has been some concern regarding the safety of surgery in older patients, GreenLight PVP has been shown to be safe and effective in the elderly.[18]

In the early postoperative period, we observed individuals with UR experiencing longer catheterization times than the LUTS group (median 1.5 vs. 1.0 days, p<0.001). Our findings are similar to Goueli et al, who looked at GreenLight PVP in patients with and without AUR. They reported mean catheterization times of 1.2 and 0.9 days for patients with and without UR, respectively.[12] Aho and colleagues assessed HoLEP outcomes in patients with AUR, CUR, and LUTS, reporting one day as a median time for the first TOV among all comparison groups studied.[8] Ruszat et al assessed patients in recurrent UR (RUR), demonstrating mean catheterization time as 1.7 vs. 1.8 days in RUR and non-RUR groups undergoing GreenLight PVP, respectively.[19] In contrast, Mustafa and colleagues observed a median postoperative catheterization time of 7.77 days.[13] This variation may reflect differences in practice preferences among various sites and clinicians.

We also report a higher proportion of patients with UR experiencing recurrent retention in the early postoperative period compared to their counterparts with LUTS (12.5% vs. 0%, p=0.008). Interestingly, the UR and LUTS groups exhibited no significant difference in the rate of successful first TOV (83% vs. 80%, p>0.05). There were no significant differences in AUR and CUR concerning postoperative catheterization time, successful first TOV, or recurrent retention. Previous studies reveal some variability with respect to these parameters. Goueli et al compared patients who underwent GreenLight PVP with and without AUR but did not identify a significant difference in success of the first TOV.[12] In contrast, Aho et al reported lower success rates during the first TOV in individuals with CUR compared to those with AUR, as well as in patients with UR compared to LUTS undergoing HoLEP.[8] Joshi and colleagues compared patients with UR and LUTS who received ablative therapy, either GreenLight or HoLEP, and noted a higher failure in the UR group with respect to the first TOV.[20] The variation in findings across studies presents an intriguing area for further research.

Throughout the followup period, we noted significant differences in PVR among the comparison groups. The UR group exhibited elevated PVR levels during the earlier followup visits, with no significant difference observed at 12 months postoperative. When comparing AUR and CUR groups, our analysis revealed elevated PVR levels in the CUR cohort during intermediate followup assessments but not at 12 months. Goueli et al reported that patients with AUR had higher postoperative PVR values in comparison to the LUTS group.[12] Conversely, Ruszat and colleagues observed no difference in PVR between patients with and without RUR following GreenLight PVP.[19]

The UR group also exhibited a significantly lower catheter-free rate one year postoperatively when compared to the LUTS group (87.5% vs. 100%, p=0.008); however, this difference was not observed in the analysis of AUR vs. CUR.

The variability in catheter-free rates following GreenLight PVP in patients with UR has been documented in previous studies.[11,12,20] In some regards, the increased rate of catheterization raises valid concerns, as maintaining a catheter-free status and enhancing QoL are pivotal goals linked to BPH interventions. Interestingly, measures such as peak flow rate (Qmax), QoL, and IPSS did not differ significantly at any time point in both comparisons. The absence of differences in subjective measures, such as QoL and IPSS, and objective measures, including Qmax, stress incontinence, and overall surgical complications, suggest that GreenLight PVP is

safe and efficacious for patients with both AUR and CUR up to at least one year postoperatively.

Many studies have assessed the outcomes of UR patients following laser-based treatments and there has been growing evidence demonstrating favorable outcomes in these patients, regardless of preoperative UDS findings.[3,8,11] The recent UPSTREAM trial suggested there is minimal evidence demonstrating how the results from UDS affect symptom outcome.[16] While our study did not include UDS, it does contribute to the growing body of research suggesting that patients with AUR or CUR are surgical candidates for de-obstructing surgery, with generally favorable outcomes and good safety profiles.

Limitations

We acknowledge several limitations to our study. First, it is a retrospective study completed at a single center and is subsequently affected by selection bias. Additionally, we present a relatively small dataset with followup for only 12 months. Future studies may seek to determine the longer-term durability of GreenLight PVP. We did not assess UDS in our study, which could provide further insight into its utility in predicting successful surgical outcomes.

CONCLUSIONS

GreenLight laser prostatectomy is an effective and durable treatment for UR, with low morbidity, as well as short catheterization time and hospital stay. The procedure provides immediate postoperative symptom improvement, with a high catheter-free rate and comparable outcomes when performed to manage LUTS.

COMPETING INTERESTS: The authors do not report any competing personal or financial interests related to this work.

This paper has been peer-reviewed.

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